DOCUMENT RESUME

ED 121 260 IR 003 235

AUTHOR Aagard, James A.; Braby, Richard
TITLE Learning Guidelines and Algorithms for Types of Training Objectives. Final Report, February 1974-March 1976.
INSTITUTION Naval Training Equipment Center, Orlando, Fla. Training Analysis and Evaluation Group.
REPORT NO TAEG-R-23
PUB DATE Mar 76
NOTE 82p.; Focus on the Trained Man series; Some charts in document may not reproduce clearly due to type size of original

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage
DESCRIPTORS Algorithms; Flow Charts; Guidelines; *Instructional Design; Instructional Systems; *Learning Processes; *Learning Theories; Military Training; Post Secondary Education; Recall (Psychological); Sequential Learning; Task Analysis; Training; *Training Objectives
IDENTIFIERS Learning Algorithms; *Learning Strategies

ABSTRACT

Strategies are presented for the following classes of training objectives: recall of knowledge, use of verbal information, rule learning and use, decision making, detecting, classifying, identifying symbols, voice communication, recall of procedures and positioning, steering and guiding, continuous movement, and performance of gross motor skills. The training strategy for each class of objectives has three parts. The first is a definition of the class of objectives and a description of the uniqueness of each class. The second is a set of learning guidelines based on both learning theory and practical experience. The third part is a learning algorithm expressed as a flow chart of a sequence of learning events. The guidelines and algorithms may be used by training system designers in specifying learning activities, selecting instructional methods, designing and evaluating mateirals, and recording field experience for use in improving the guidelines and algorithms. (Author/CH)

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TAEG Report No. 23

LEARNING GUIDELINES AND ALGORITHMS FOR TYPES OF TRAINING OBJECTIVES

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March 1976

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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FOREWORD

The guidelines and algorithms of this report are intended to be used by experienced professional training system designers and managers who will be tasked with the planning, design, and utilization of training systems. These professionals should be versed in the psychology of learning and be acquainted with the terminology.

A simplified version of these guidelines has been published separately by the Navy for personnel inexperienced in the application of the principles of learning. The translation of these guidelines was done by the Center for Educational Technology, Florida State University, and the resulting instructional guidelines are presented as a part of Appendix VIII-A, the Interservice Procedures for Instructional Systems Development (August 1975).

These guidelines and algorithms are supported by varying amounts of empirical data, but all have at least a basis core of empirical support. The categories of tasks are neither comprehensive nor entirely independent of each other. Finally, it is important that these guidelines and algorithms should be used in conjunction with another report (Briggs, Reavy, Parrish, and Swope, 1975) which concerns job task similarity, training media, and training cost factors to form the entire decision basis for decision making in the design of instructional systems.

[illegible] Report No. 31

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The authors wish to thank members of the Center for Educational Technology at Florida State University for encouraging the development of the architecture and algorithms and for suggestions in implementing the architecture. Their suggestions aided in the [illegible] of this paper. Many architects for incorporation in the Instructional Systems Development. This effort was directed by Robert A. Bradekamp, Walter W. Wagner, J. Robert Yow, and Barbara B. Anderson.

Appreciation is also expressed to Dana S. Mitchell for valuable suggestions and inputs to this report.

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[illegible]

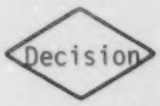
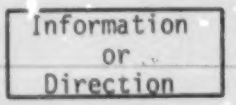
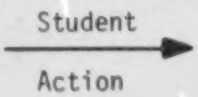
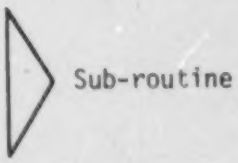
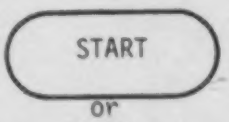
[illegible]

In the process of designing training systems, professionals must [illegible] training [illegible] and costly knowledge and practices in the [illegible] Consequently, the requirements of [illegible] training [illegible] [illegible] [illegible]

TABLE 1. ELEVEN TYPES OF ELEMENTAL LEARNING TASKS (continued)

NAMES OF LEARNING TASKS	CHARACTERISTICS OF TRAINING OBJECTIVES WITHIN TASK CATEGORIES		
	ACTION VERBS	BEHAVIORAL ATTRIBUTES	EXAMPLES
8. RECALLING PROCEDURES, POSITIONING MOVEMENT	Activate Adjust Align Assemble Calibrate Disassemble Inspect Operate Service	1. Concerns the chaining or sequencing of events. 2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. 3. Procedural check lists are frequently used as job aids.	1. Recalling equipment assembly and disassembly procedures. 2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists). 3. Following equipment turn-on procedures - emphasis on motor behavior.
9. GUIDING AND STEERING, CONTINUOUS MOVEMENT	Control Guide Maneuver Regulate Steer Track	1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc. 2. Compensatory movements based on feedback from displays. 3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol. 4. Involves estimating changes in positions, velocities, accelerations, etc. 5. Involves knowledge of display-control relationships.	1. Submarine bow and stern plane operators maintaining a constant course, or making changes in course or depth. 2. Tank driver following a road. 3. Sonar operator keeping the cursor on a sonar target. 4. Air-to-air gunnery - target tracking. 5. Aircraft piloting such as visually following a ground path. 6. Helmsman holding a course with gyro or magnetic compass.
10. PERFORMING GROSS MOTOR SKILLS	Carry Crawl Fall Jump Lift Run Swim Throw	1. Perceptual - motor behavior - emphasis on motor. Premium on manual dexterity, occasionally strength and endurance. 2. Repetitive mechanical skill. 3. Standardized behavior, little room for variation or innovation. 4. Automatic behavior - low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior. 5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate. 6. Fine tolerances.	1. From a kneeling position, throw an M67 fragmentation hand grenade 40 meters on target within effective casualty radius (ECR) using acceptable technique. 2. Wearing a utility jacket, utility trousers, combat boots and armed with M16 rifle, traverse 75 meters in deep water using correct form. 3. Demonstrate the proper technique for a parachute landing fall (PLF) in open terrain. 4. Demonstrate the proper technique of creeping at night across open terrain armed with a rifle. 5. Demonstrate the proper technique of chin-ups starting from "dead hang; palms toward face position.

TABLE 2. ALGORITHM SYMBOLS AND MEANINGS

Symbol	Meaning
	A decision or branch point - divides the flow into 2 or more paths.
	Information or directions for program designer or student.
	Represents student responses, either an answer or movement to a new block in the flow.
	A special sequence of events not presented in the flow, such as a pretest.
	A file of rules, exercises, or student scores; any of these items can be called up as required.
	A technique for connecting the student action lines on two pages of a flow chart (or algorithm).
	A symbol for starting a flow or stopping the various paths of that flow.

The 11 learning strategies are presented in the remainder of this section. They appear in the order listed in table 1. Since each strategy is defined in operational terms, it may at times be necessary to refer to table 1 and the glossary for clarification of key words.

A. RECALLING BODIES OF KNOWLEDGE

This category encompasses the learning, recognizing, and recalling of the verbal information needed to function in an operational setting. It includes knowledge of equipment nomenclature, functions, configurations, locations, control inputs, output displays, and the complex relationships between inputs, outputs, and possible equipment malfunctions. Most academic training is of this kind, and therefore students learning these tasks have been readily accessible as subjects for investigators studying the learning and recall of verbal information. The following guidelines are a translation of the findings of this research. The algorithm representing these guidelines is presented in figure 1.

1. Communicate objectives of training to the student at the beginning of the training period.

2. Organize the learning material to meet the stated objectives. Organize training around important cue components (key words, formulas, or phrases) within the body of facts or principles.

3. Provide some warm-up exercises immediately prior to testing for recalling bodies of knowledge.

4. Make learning tasks relevant; i.e., similar to real-life tasks that the student will be performing on the job.

5. Compare directly the names or other data that are similar, or separate their presentation by as much time as possible to avoid confusion.

6. Make sure the students can tell the difference between two or more salient cues that are difficult to distinguish in the operational context before associating each with a response during training.

7. Use mnemonics (association devices) which will cause an affective reaction in the student to aid recall whenever possible.

8. Use mnemonics which will aid in the association of the cue and response terms in the recall of facts or principles. Provide directions for the student to develop his own mnemonics if he can and wants to do it.

9. Arrange for features of the real-world job setting to be used to trigger the student's recall of associated cues which, in turn, will call to mind the knowledge he needs to perform his job.

10. Select attention-getting cues to use throughout the learning events. Select learning activities that require student involvement.

11. Guide (or prompt) the student's response, especially in the early phase of training. Later in training, remove guides to match the level of guides (or prompts) in the operational setting.

12. Arrange for practice of recalling the verbal information by providing retrieval tests very similar to the tests that the student will encounter in the operational setting.

13. Require the student to make an overt response which will show his recall of the facts or principles which, in turn, will enable measurement of his response.

14. Arrange for knowledge of results (KOR) to follow both correct and incorrect responses. Also arrange for positive reinforcement to be interspersed throughout the training following correct recall of facts.

15. Schedule KOR to be presented immediately after a response for maximum effect of KOR.

16. Change the order of presenting facts and principles during practice so that each item in the list of information will be learned equally well.

17. Practice should be distributed (interspersed with rest periods) during training periods especially with (1) the learning of large bodies of facts or (2) complex information. This is particularly useful with slow learners.

18. Individualize instruction to the extent possible. In order for slow learners to reach the same criterion as fast learners, arrange for slow learners to have a higher total number of reinforcements of correct responses than the fast learners.

19. Arrange for the student to compare the program's stated objectives with his status in meeting these objectives (use periodically).

20. Test to determine if the student is able to correctly recall key features of the job setting which serve as cues to him in recalling the knowledge he needs in performing his job.

21. Prevent decay of recall by:

a. Increasing the meaningfulness of the material to be learned (relating it to the student's operational environment) and by relating the organized facts or principles to each other.

b. Requiring the student to overlearn the original material (an essential procedure to reduce forgetting).

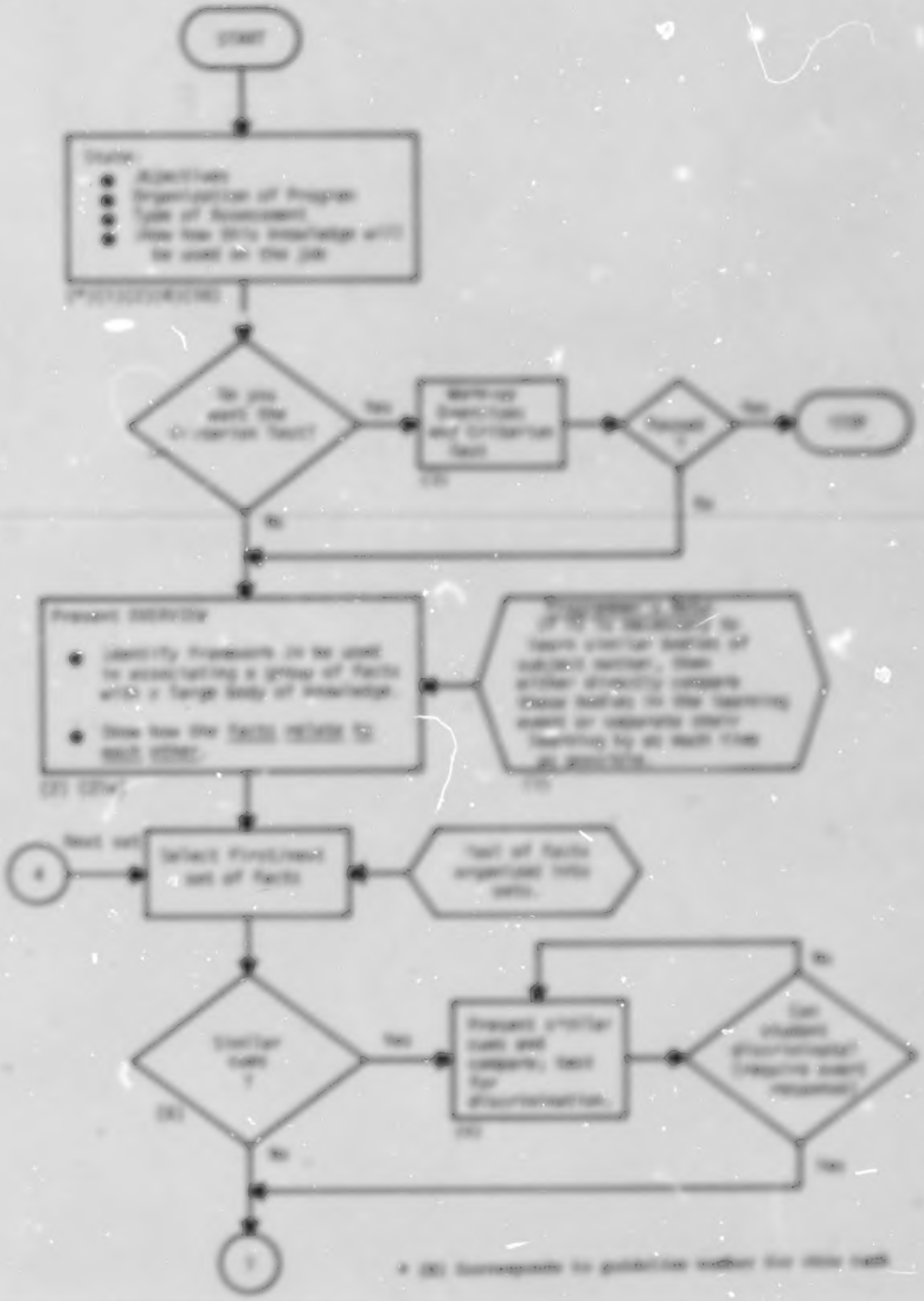


Figure 1. Learning Algorithm for Recalling Bodies of Knowledge

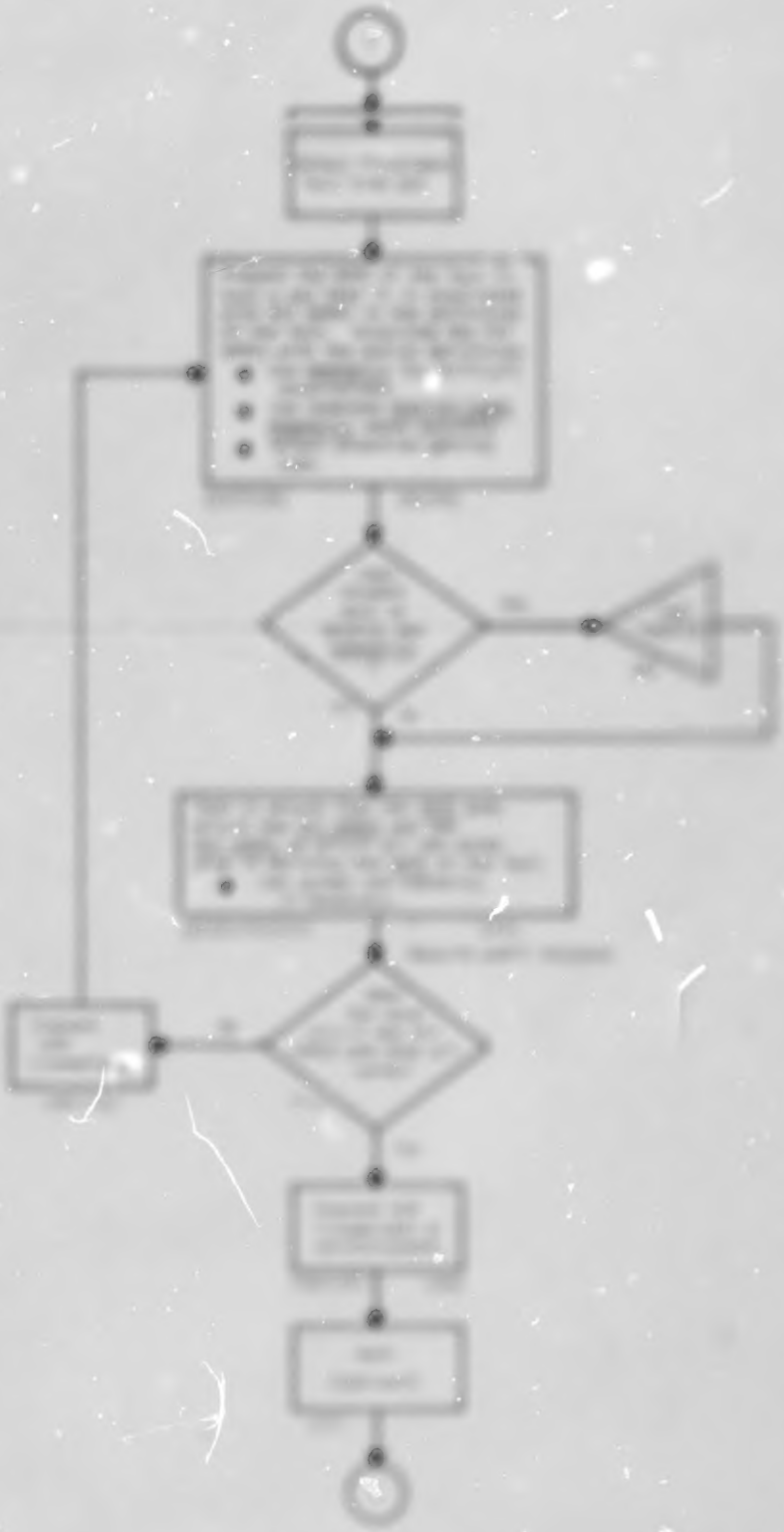


Figure 1. Learning Algorithm for Revising Bodies of Knowledge (continued)

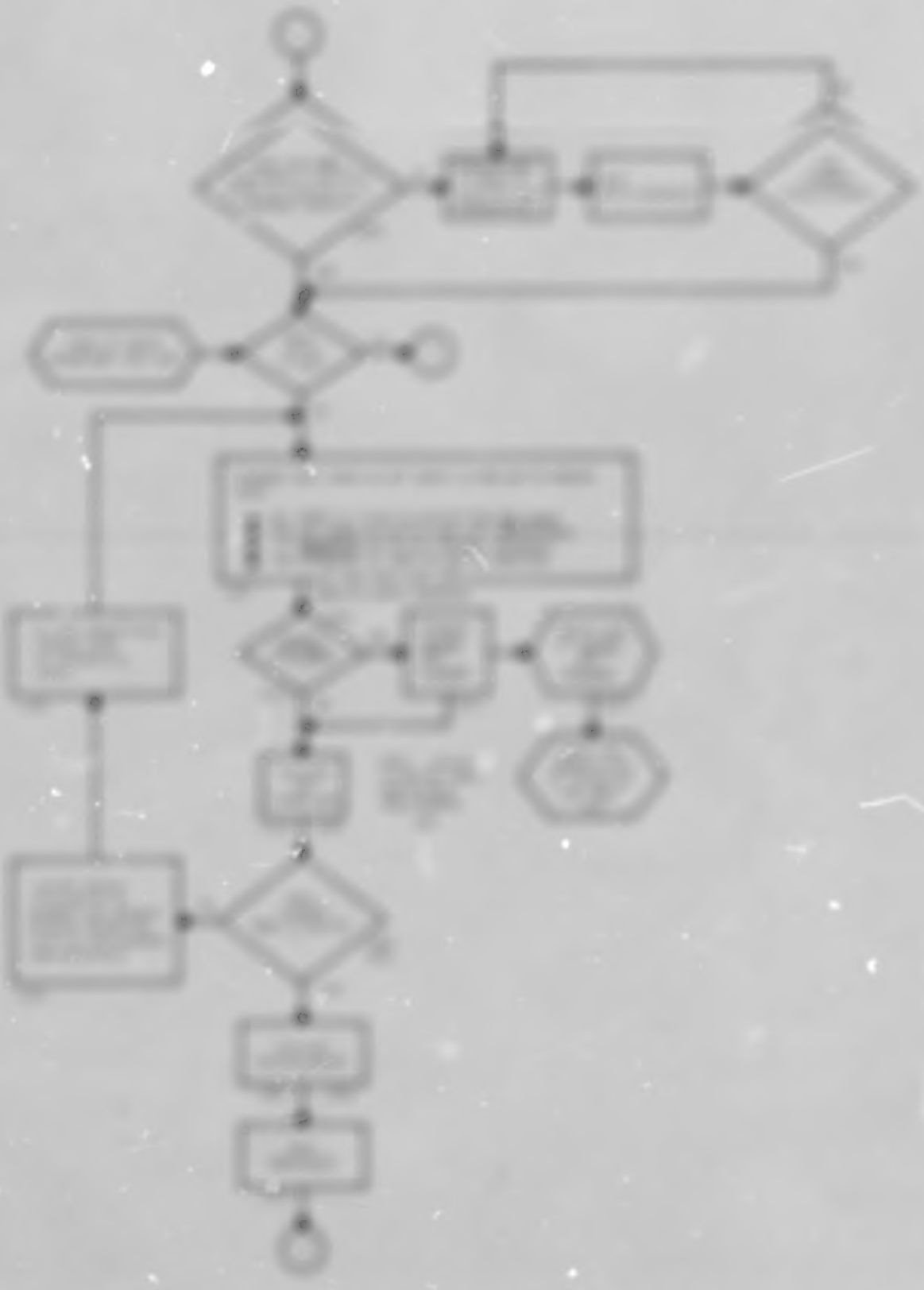


Figure 1. Learning Algorithm for Modifying Matrix of Associative Loci Proposed

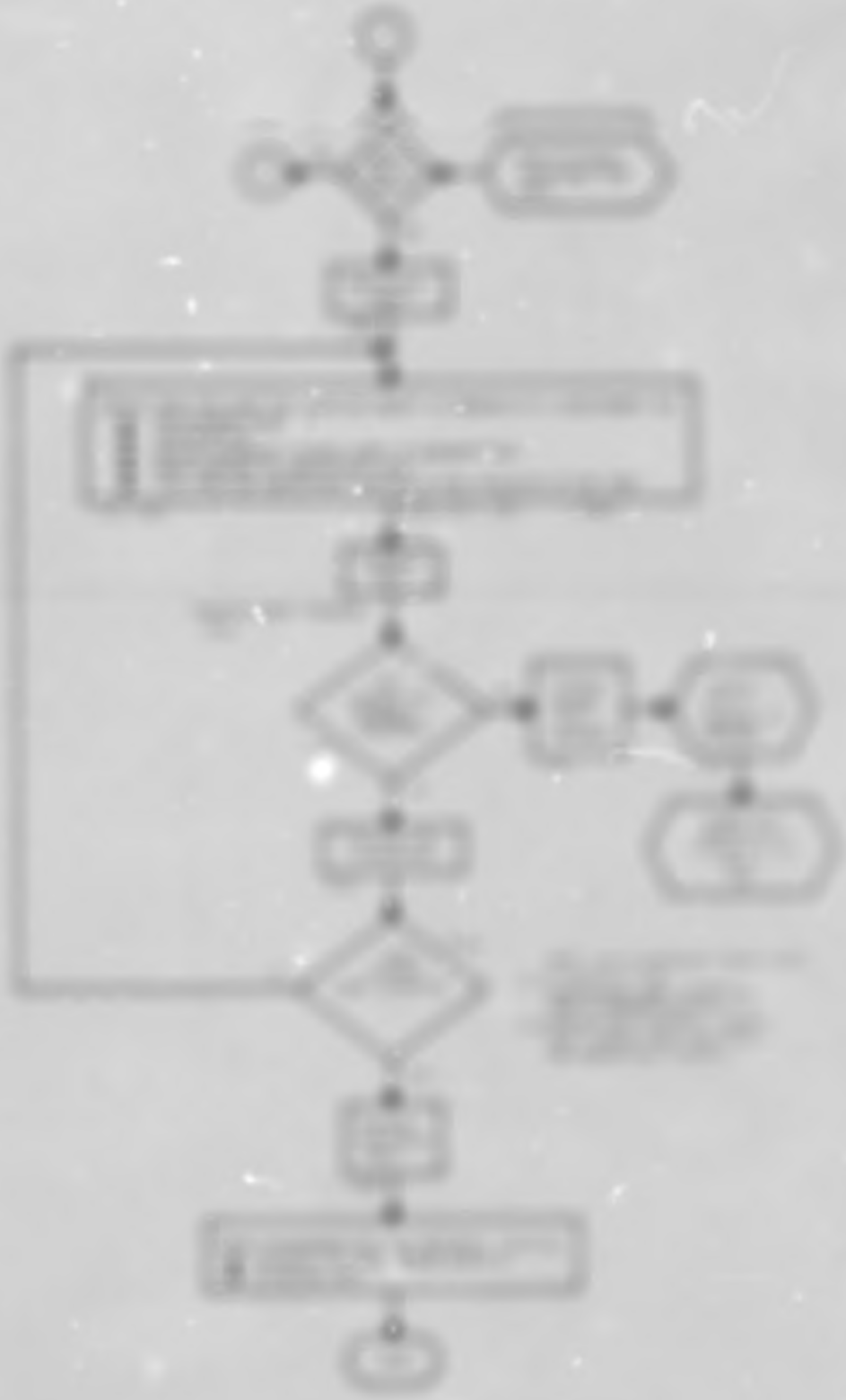
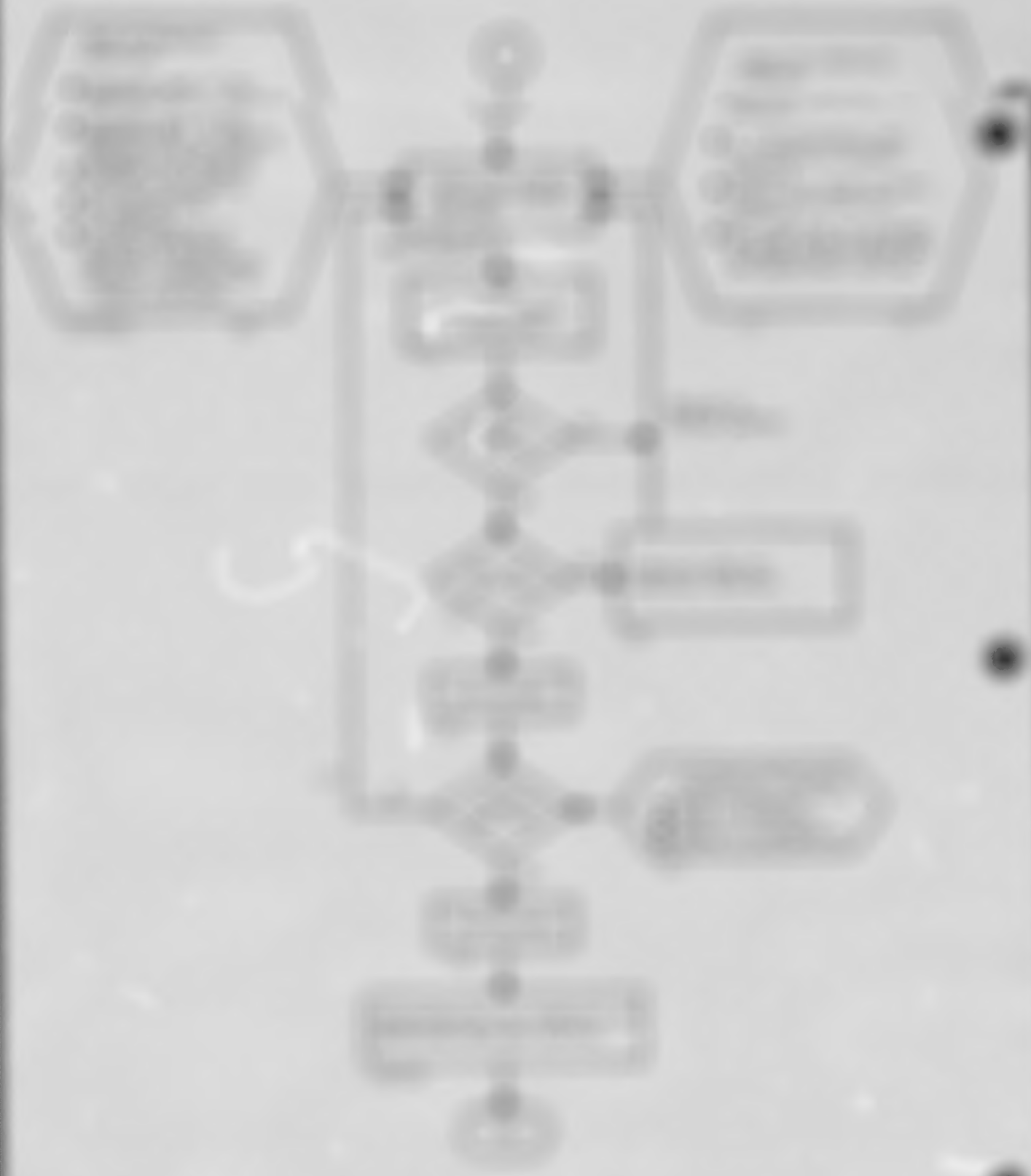


Figure 1. Learning Algorithm for Modifying Matrix of Weights (continued)

[illegible]



learns to apply the rules across the range of situations he will find in the operational job setting.

8. Reduce the frequency of reinforcement of correct applications at the end of training to a level that exists in his job setting.

9. Relate the rules to be learned to the operational job setting in order to provide motivation for rule learning.

10. Provide for (1) individualized learning to allow for individual differences in learning and (2) periodic refresher training when the student has had an extended absence from performing the job.

11. Guide the student to discover a useful rule by having him respond to a sequence of leading questions, if the student is having a difficult time understanding and applying a rule.

12. Arrange for slow learners to have a higher total number of reinforcements of correct responses than the fast learners.

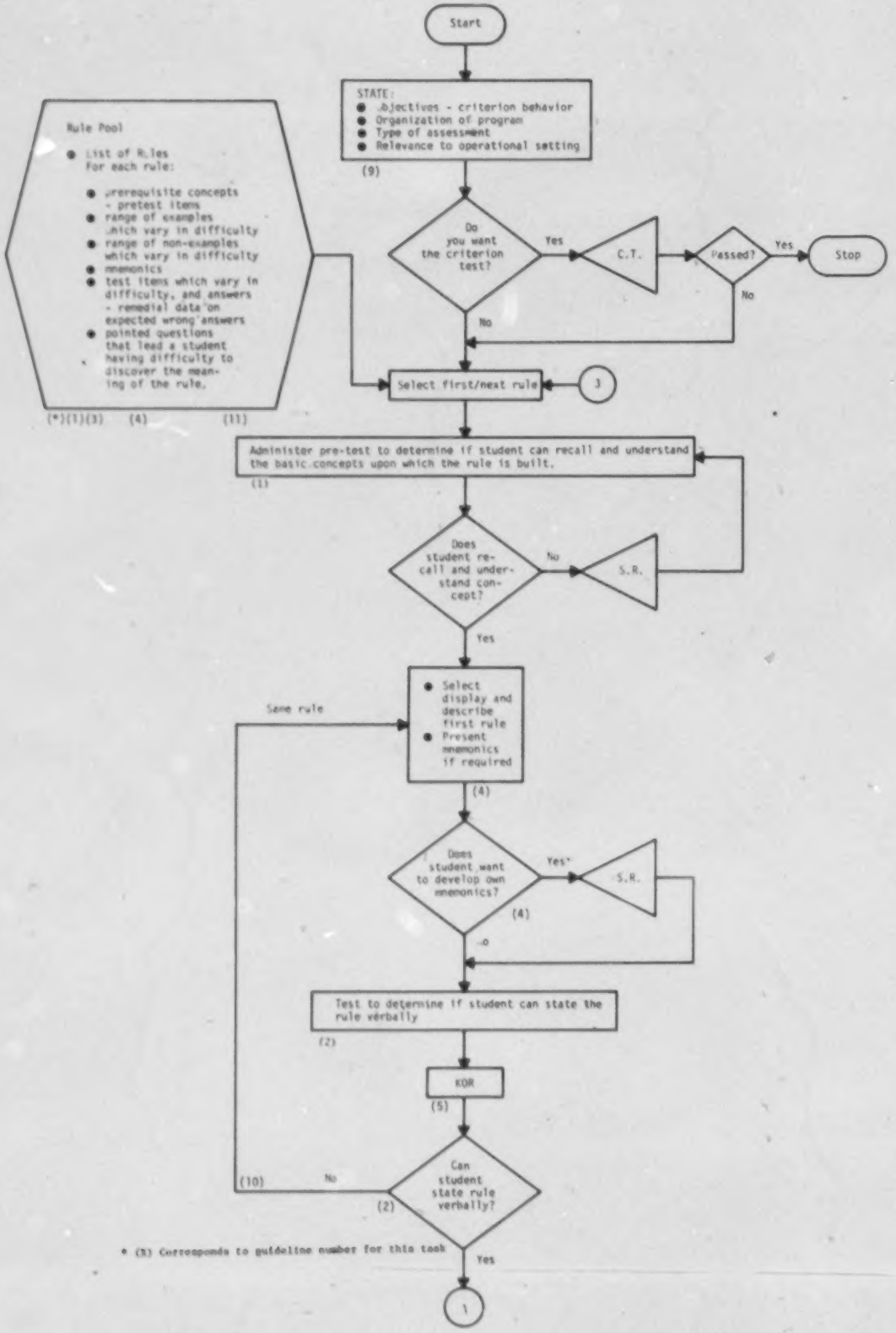


Figure 3. Learning Algorithm for Rule Learning and Using

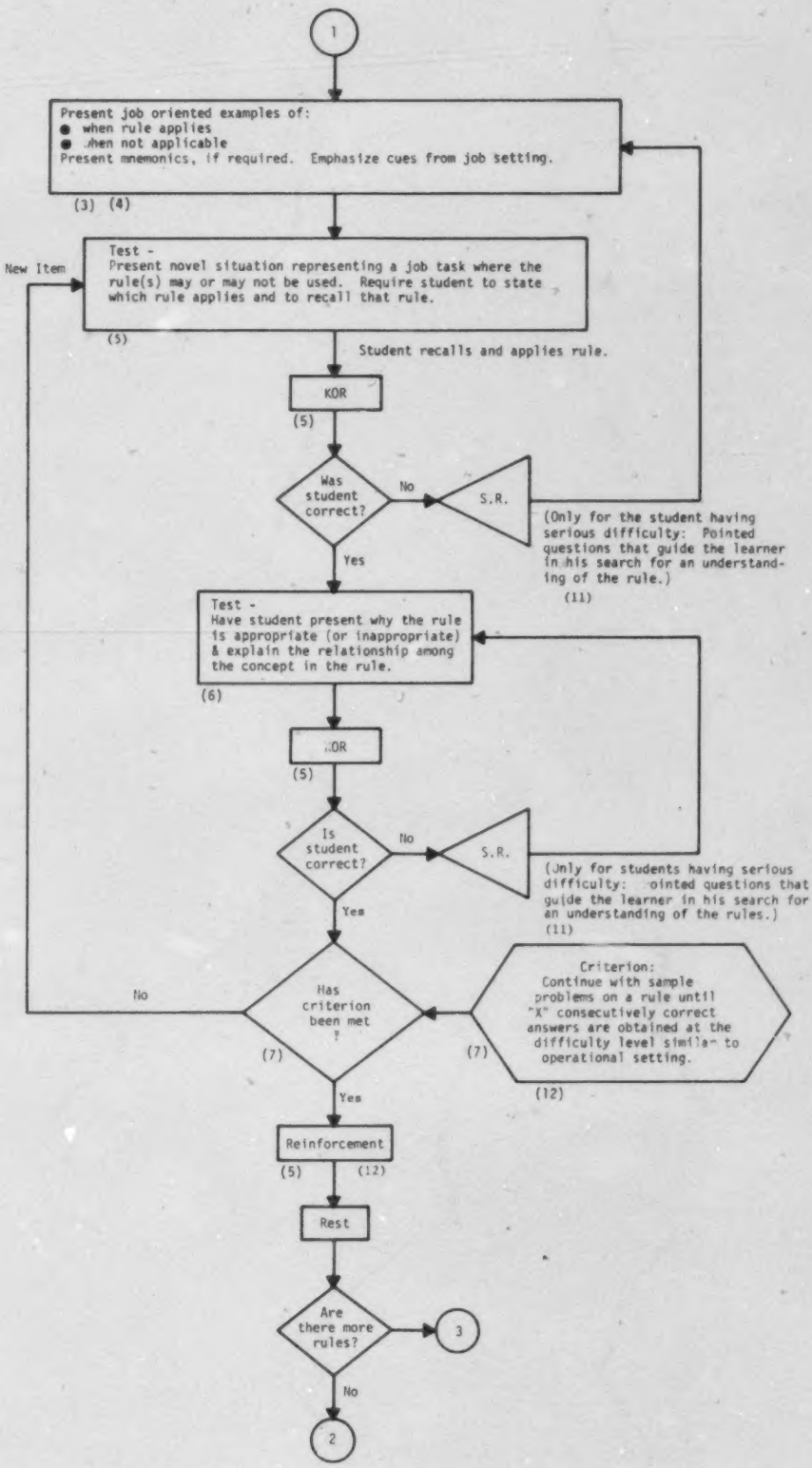

1
Present job oriented examples of:
● when rule applies
● when not applicable
Present mnemonics, if required. Emphasize cues from job setting.
(3) (4)
New Item
Test -
Present novel situation representing a job task where the rule(s) may or may not be used. Require student to state which rule applies and to recall that rule.
(5)
Student recalls and applies rule.
KOR
(5)
Was student correct?
No
S.R.
(Only for the student having serious difficulty: Pointed questions that guide the learner in his search for an understanding of the rule.)
(11)
Yes
Test -
Have student present why the rule is appropriate (or inappropriate) & explain the relationship among the concept in the rule.
(6)
KOR
(5)
Is student correct?
No
S.R.
(Only for students having serious difficulty: Pointed questions that guide the learner in his search for an understanding of the rules.)
(11)
Yes
No
Has criterion been met ?
(7)
Criterion:
Continue with sample problems on a rule until "X" consecutively correct answers are obtained at the difficulty level similar to operational setting.
(7)
(12)
Yes
Reinforcement
(5)
(12)
Rest
Are there more rules?
3
No
2

Figure 3. Learning Algorithm for Rule Learning and Using (continued)

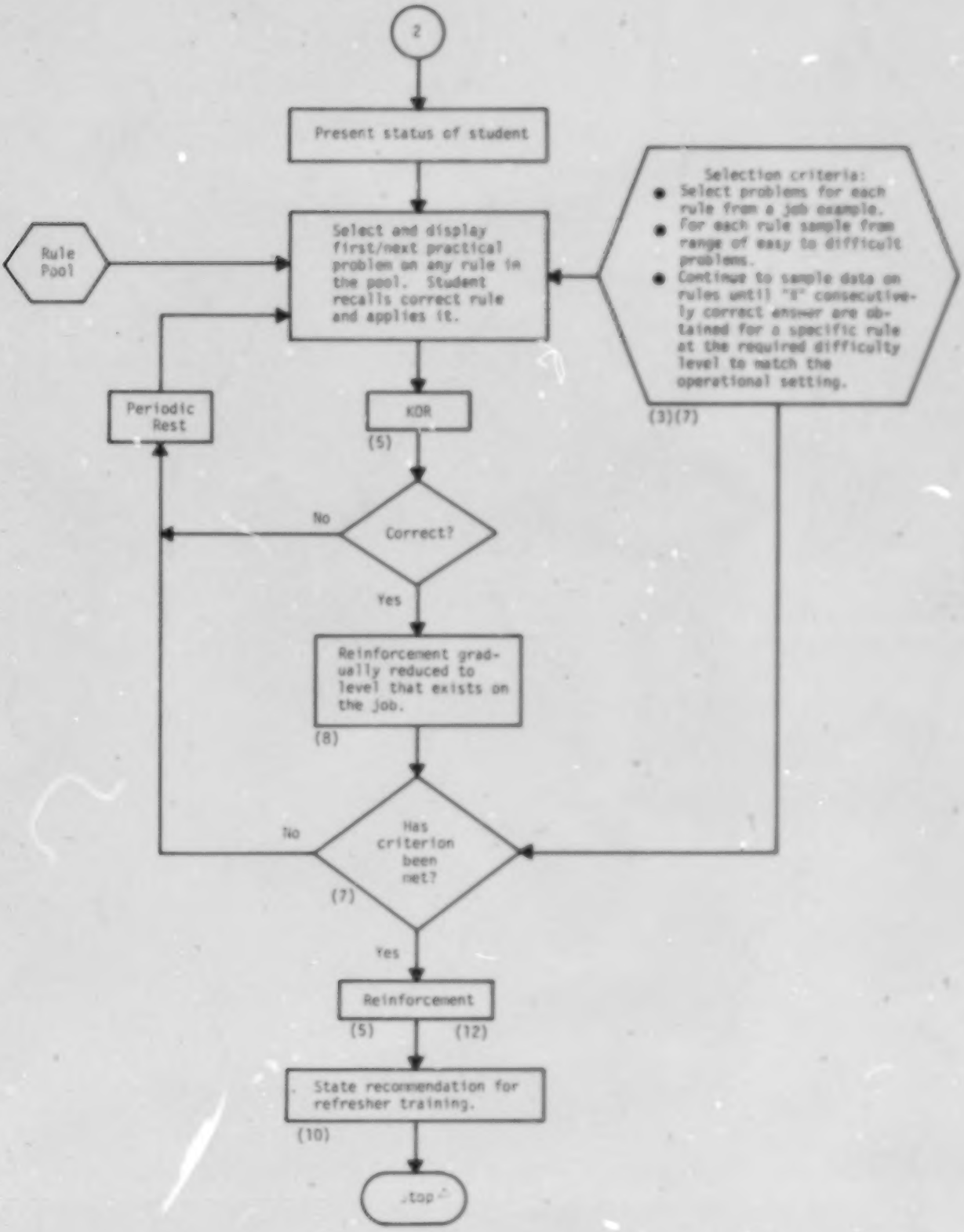

2
Present status of student
Rule Pool
Select and display first/next practical problem on any rule in the pool. Student recalls correct rule and applies it.
Selection criteria:
• Select problems for each rule from a job example.
• For each rule sample from range of easy to difficult problems.
• Continue to sample data on rules until "E" consecutively correct answer are obtained for a specific rule at the required difficulty level to match the operational setting.
(3)(7)
Periodic Rest
KOR
(5)
No
Correct?
Yes
Reinforcement gradually reduced to level that exists on the job.
(8)
No
Has criterion been met?
(7)
Yes
Reinforcement
(5)
(12)
State recommendation for refresher training.
(10)
Stop

Figure 3. Learning Algorithm for Rule Learning and Using (continued)

D. MAKING DECISIONS

Decision making is defined here as the application of a specific decision model, thought to be useful in diagnosing equipment malfunctions, choosing tactics in Fleet operations, and in planning where several alternatives must be considered, each with an unknown probability of success. The decision model combines the following factors: perception of the problem, identification of alternative solutions, evaluation of these alternatives and selection of the apparent best solutions. Therefore, the guidelines and algorithm presented here support learning to use this decision model.

The decision-making guidelines presented here are based upon the most fashionable practices in existing decision-making training programs.

The following guidelines apply to decision making training. The algorithm representing these guidelines is presented in figure 4.

1. Ensure that the student acquires the knowledge required to:

   a. identify the problem,

   b. generate reasonable solutions,

   c. evaluate these solutions.

2. Decrease student anxiety to a low level, particularly in the early stages of training, where student anxiety is high and where complex decisions are to be made.

3. Give the student examples of these two types of actions which are to be avoided when making a decision:

   a. The tendency to make a "favorite" decision or use a "favorite" solution regardless of the real nature of the problem.

   b. The tendency to generalize problems or view several types of problems as if they were all the same when, in fact, they are quite different.

Give examples of these undesirable responses in decision making.

4. Teach a decision-making strategy; the following strategy is suggested:

   a. Upon becoming aware of the problem, define it.

   b. Be alert for the availability of relevant information and collect such data.

c. Develop alternative solutions.

(1) State alternative solutions.

(2) Combine alternative solutions.

(3) Compare alternative solutions.

d. Evaluate alternative solutions.

(1) List the probable consequences of each alternative solution.

(2) Rank each alternative solution according to desirability of consequences.

e. Choose course of action based on a desired solution.

f. Execute the chosen course of action.

5. Vary the setting of the significant cues of the decision-making learning task. Provide both basic and advanced problems to be solved with a wide range of problem difficulty at each level of training for the operational tasks.

6. Insure the overlearning of decision-making skills in later stages of training if the student will be required to perform under stress in the real world.

7. Present the student with a realistic data load (i.e., realistic amount of significant data) plus operational distractors in real time toward the end of training.

8. Provide the student with access to potentially relevant data during practice. In the final stage of training, the data available to him should be limited to that expected in the real world situations in which he will be working.

9. Provide the student with answers to the five following questions after his decisions in practice problems. These answers serve as knowledge of results (KOR).

a. Predictability? (Were problems mistakenly viewed as if they were all the same in reaching solutions?)

b. Persistence? (Was use made of a "favorite" solution when it was inappropriate?)

c. Timeliness? (Was this the appropriate time to execute this particular decision?)

a. [completeness? (Was all of the available information considered?)

b. [consistency? (Was the solution compatible and relevant to the available information?)

Give KSR with respect to the above five criteria each time the student makes a decision and, if possible, provide the calculated consequences of the decision as compared to alternative solutions.

Figure 6. Jamming Algorithm for Survey Variables

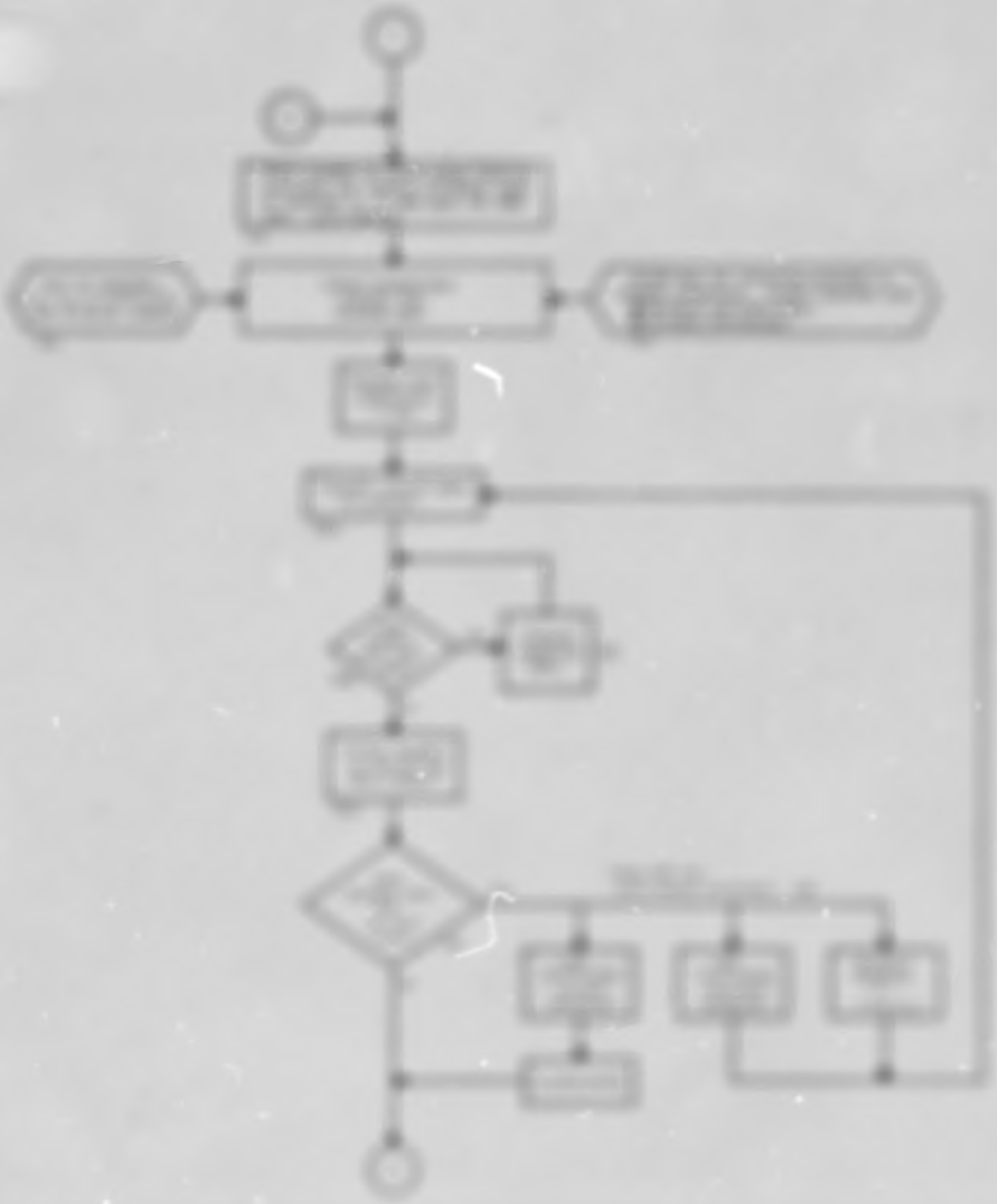
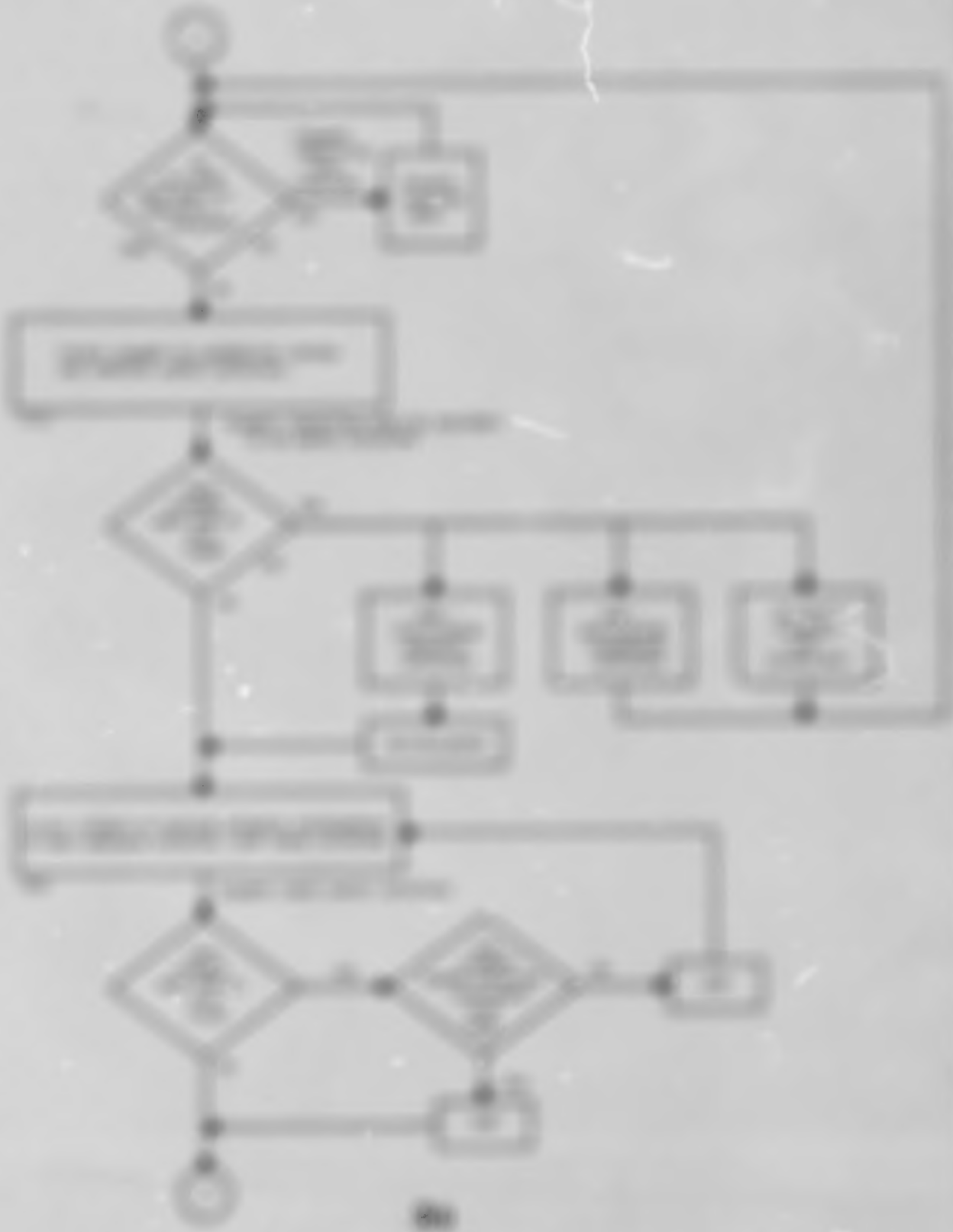
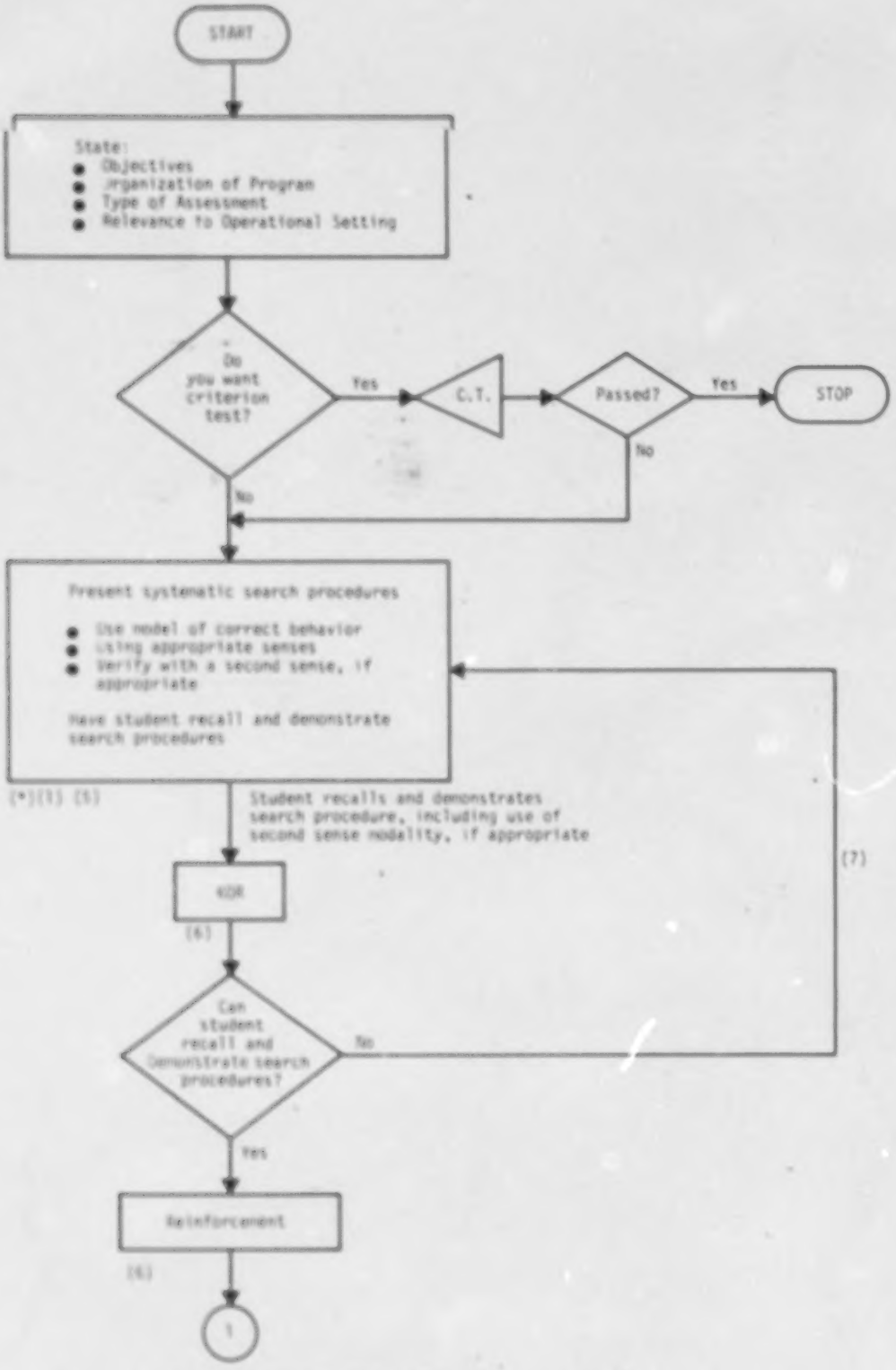


Figure 6 Learning Algorithm for Making Boundary Assignments



(b)



* (X) Corresponds to guideline number for this task

Figure 5. Learning Algorithm for Detecting

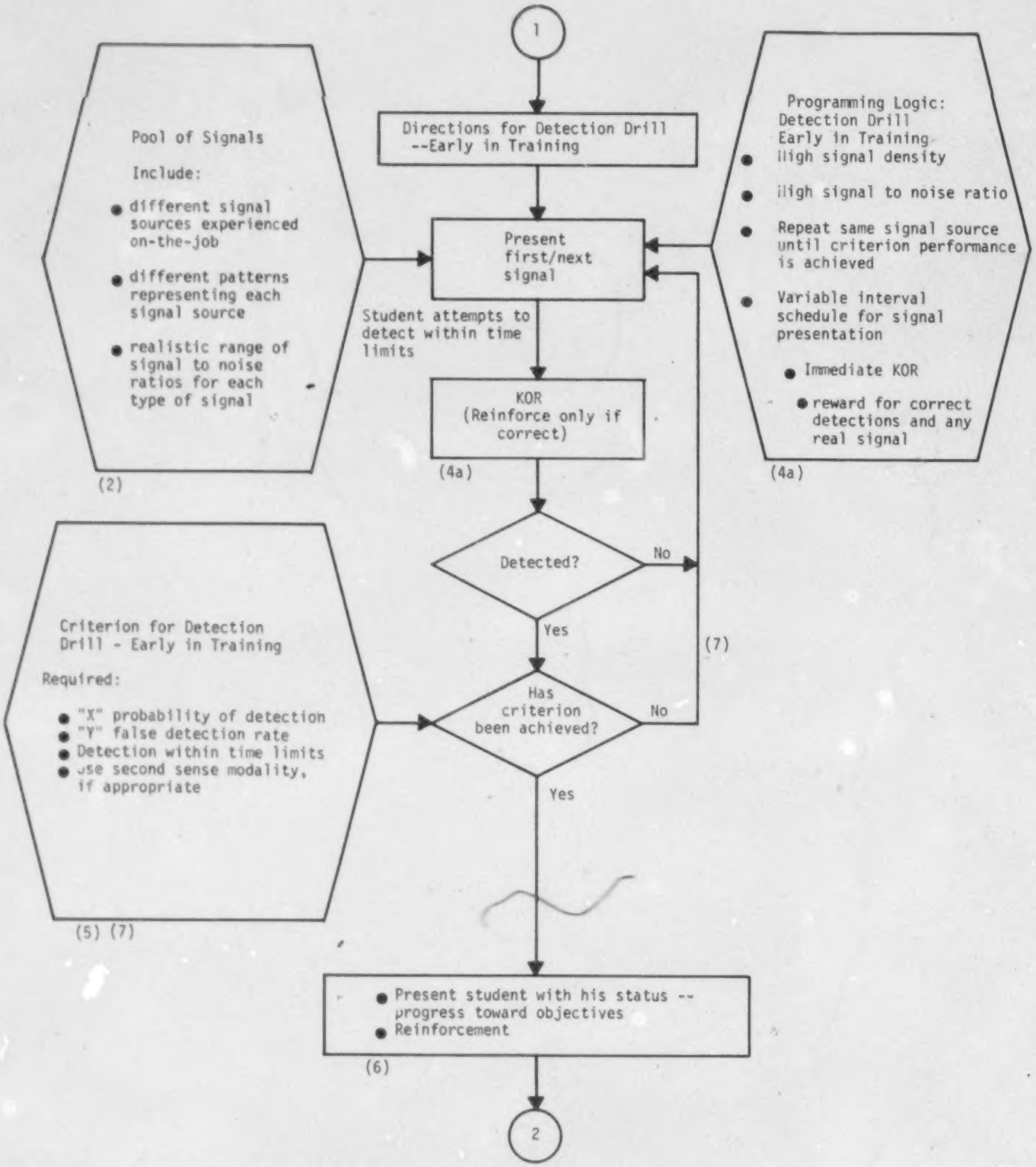


Figure 5. Learning Algorithm for Detecting (continued)

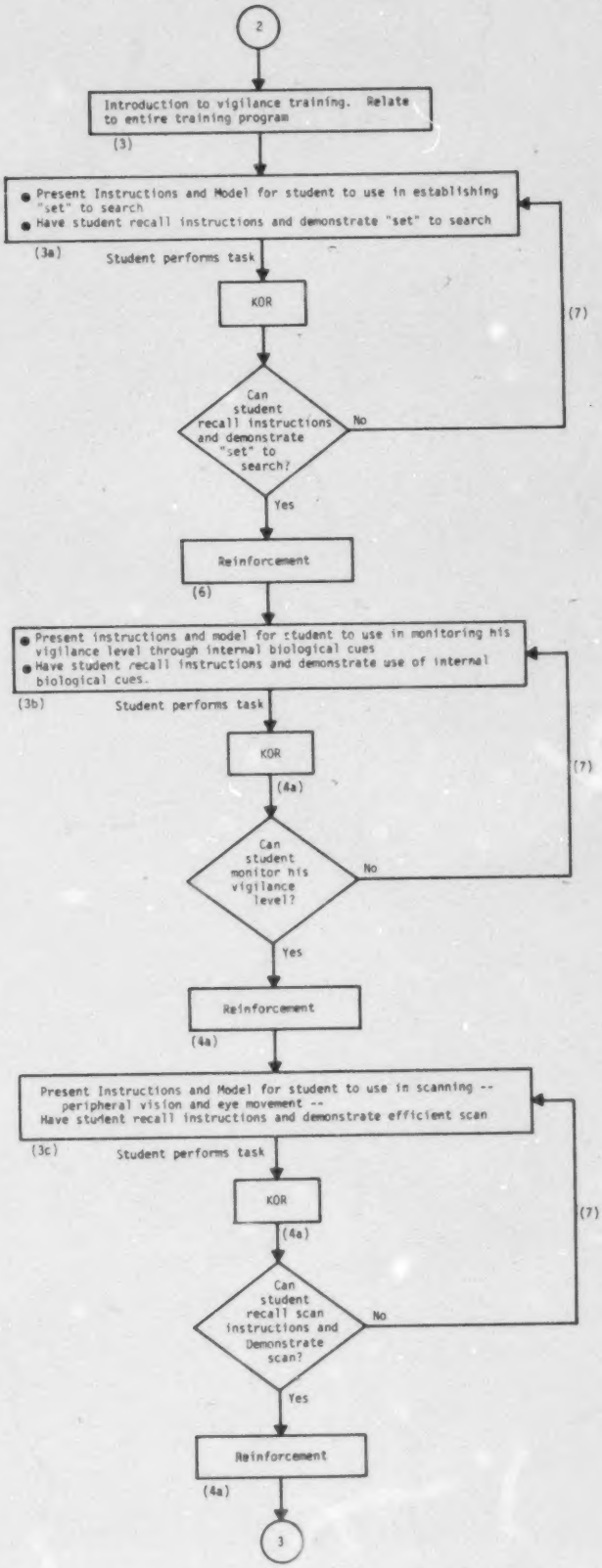


Figure 5. Learning Algorithm for Detecting (continued)

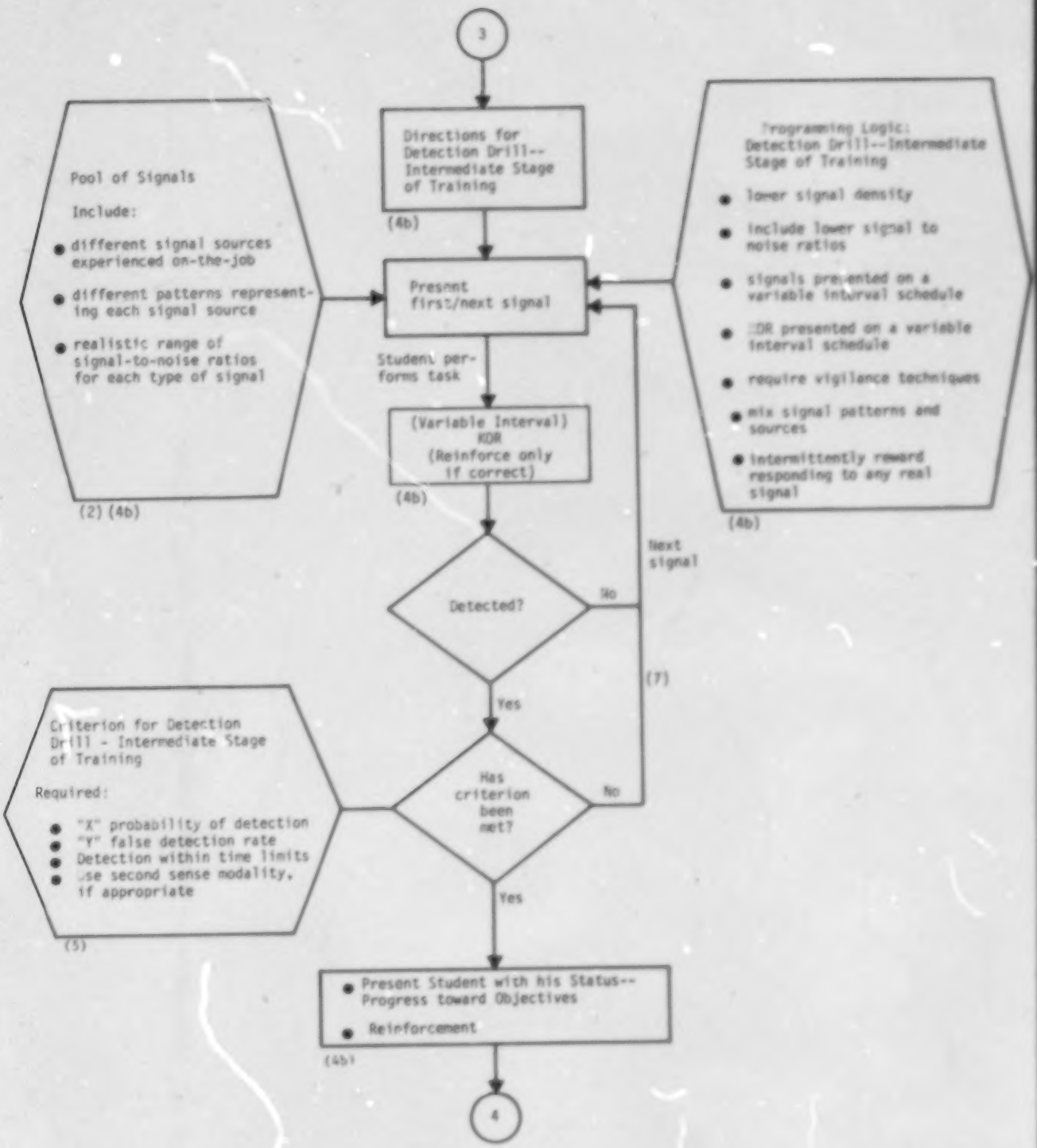

3
Directions for Detection Drill-- Intermediate Stage of Training
(4b)
Pool of Signals
Include:
● different signal sources experienced on-the-job
● different patterns representing each signal source
● realistic range of signal-to-noise ratios for each type of signal
(2) (4b)
Present first/next signal
Student performs task
(Variable Interval) KOR (Reinforce only if correct)
(4b)
Programming Logic: Detection Drill--Intermediate Stage of Training
● lower signal density
● include lower signal to noise ratios
● signals presented on a variable interval schedule
● KOR presented on a variable interval schedule
● require vigilance techniques
● mix signal patterns and sources
● intermittently reward responding to any real signal
(4b)
Detected?
No
Next signal
(7)
Yes
Criterion for Detection Drill - Intermediate Stage of Training
Required:
● "X" probability of detection
● "Y" false detection rate
● Detection within time limits
● Use second sense modality, if appropriate
(5)
Has criterion been met?
No
Yes
● Present Student with his Status-- Progress toward Objectives
● Reinforcement
(4b)
4

Figure 5. Learning Algorithm for Detecting (continued)

4
Directions for Detection Drill -- Advanced Stage of training
Pool of Signals
Include:
• different signal sources experienced on-the-job
• different patterns representing each signal source
• realistic range of signal-to-noise ratios for each type of signal
(3)
Present first/next signal
Programming Logic: Detection Drill--Advanced Stage of Training
• low signal density (operational density or minimum number suited for training)
• decrease signal-to-noise ratio to operational level
• present signals according to a variable interval schedule
• schedule KSR equivalent to operational setting.
• require vigilance techniques appropriate to the job setting
• randomize signal patterns and sources
(4a)
Student performs task
Realistically Scheduled KSR (Reinforce only if correct)
(4)
Detected?
No
Next signal
(4)
Yes
Criterion for Detection Drill -- Advanced Stage of Training
Required:
• "X" probability of detection
• "c" false detection rate
• Detection within time limits
• Use second sense modality, if appropriate
(5)
Has criterion been met?
No
Yes
Present:
• Status
• Reinforcement
(6)
Recommendations for Scheduling and Performing Refresher Training
STOP

Figure 5. Learning Algorithm for Detecting (continued)

F. CLASSIFYING

This task involves assigning a name to detected signals based on identifiable characteristics. Classifying frequently follows immediately after detecting in the operational setting as if the two were a single event, although the two processes are fundamentally different. Classifying is closely related to the forming of concepts which has been extensively studied. In fact, to a large extent, the principles of learning which are applicable to concept formation also apply to classifying. Examples of classifying in operational tasks include labeling a sonar signal as "submarine" or "nonsubmarine," naming an approaching aircraft when the distinguishing features become visible, and determining that an increasingly louder "grinding" noise is a bearing starting to disintegrate.

The following guidelines apply to classifying. The algorithm representing these guidelines is presented in Figure 6.

1. State clearly the behavioral objectives to be achieved by the student. Organize learning material around critical cues (distinguishing features of the objects) to achieve this desired behavior. Relate the objectives to the student's future real-world assignments.

2. Train the student to properly differentiate features to be used in classifying. Make sure the student can observe the differences between closely related features if these differences are important in the classification task. (As an example, properly identify blue and blue-green as being different colors.)

3. Train the student to recognize the features of a pattern (cue) that distinguish this pattern from other patterns. Use cues that will be present in the student's job.

4. Emphasize distinctive cues which can be remembered in the form of mental pictures instead of abstract words. Teach the student to transform the distinctive features of cues into terms that he can readily recall.

5. Present examples of various classes in a single exercise. Towards the end of training, present examples of classes that appear very similar in the operational setting.

6. Minimize the number of irrelevant cues in the early stages of learning. Towards the end of training, increase the number of irrelevant cues to a maximum, i.e., corresponding to the real-life situation of the job.

7. Reinforce frequently in the early stages of learning pattern recognition. Reinforce less often (or same level as the operational setting) towards the end of training.

8. Ensure that the student practices making correct identifications of the test objects.

9. Provide immediate knowledge of results (KOR) to insure correct terminal performance.

10. Provide a pause following KOR (e.g., 0.12 sec.) that is much longer than the pause between the response and KOR (e.g., 0.01 sec.). This pause provides time for the student to sort out errors and to identify salient cues of the patterns.

11. Sample from the extremes of the full range of examples of patterns produced by a given object. Make the examples more similar as training progresses. At the end of training, the characteristics of the examples should represent the characteristics that exist in the real world.

12. Provide a variety of examples of the patterns. Select examples to sample the full range of variations in the patterns. Later in the learning stage, build in distractors equivalent to those found in the operational setting.

13. Provide self-paced training that can be adapted to the individual student's needs. Both rate and level of learning depend upon characteristics of the individual student.

14. Arrange for slow learners to have a higher number of reinforcements of correct responses than the fast learners.

15. Insure the development of a strong tendency for the student to look for certain critical and distinctive cue patterns found in operational tasks.

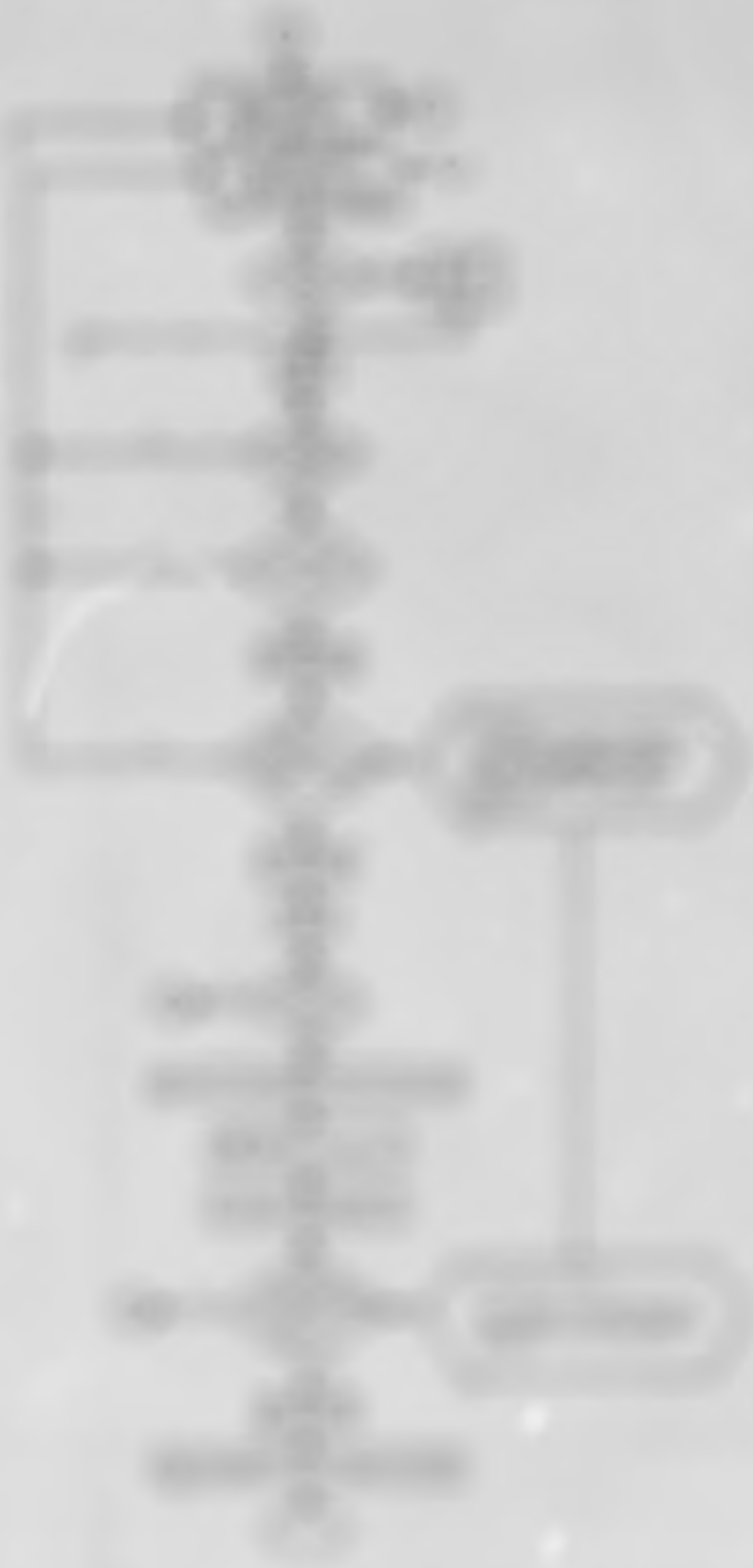
16. Require (where possible) the learner to correctly identify as many new items as examples in each classification category.

17. Prevent decay of recall by (1) requiring the student to overlearn the original material and (2) ensuring periodic refresher training.

Figure 6. Learning Algorithm for Closed-Spring

Figure 6. Learning Algorithm for Classifying Usefulness

[illegible]



10. Give specific knowledge of results with each performance of the student; reinforce correct segments of performance.

11. Provide rest periods at intervals within the training period.

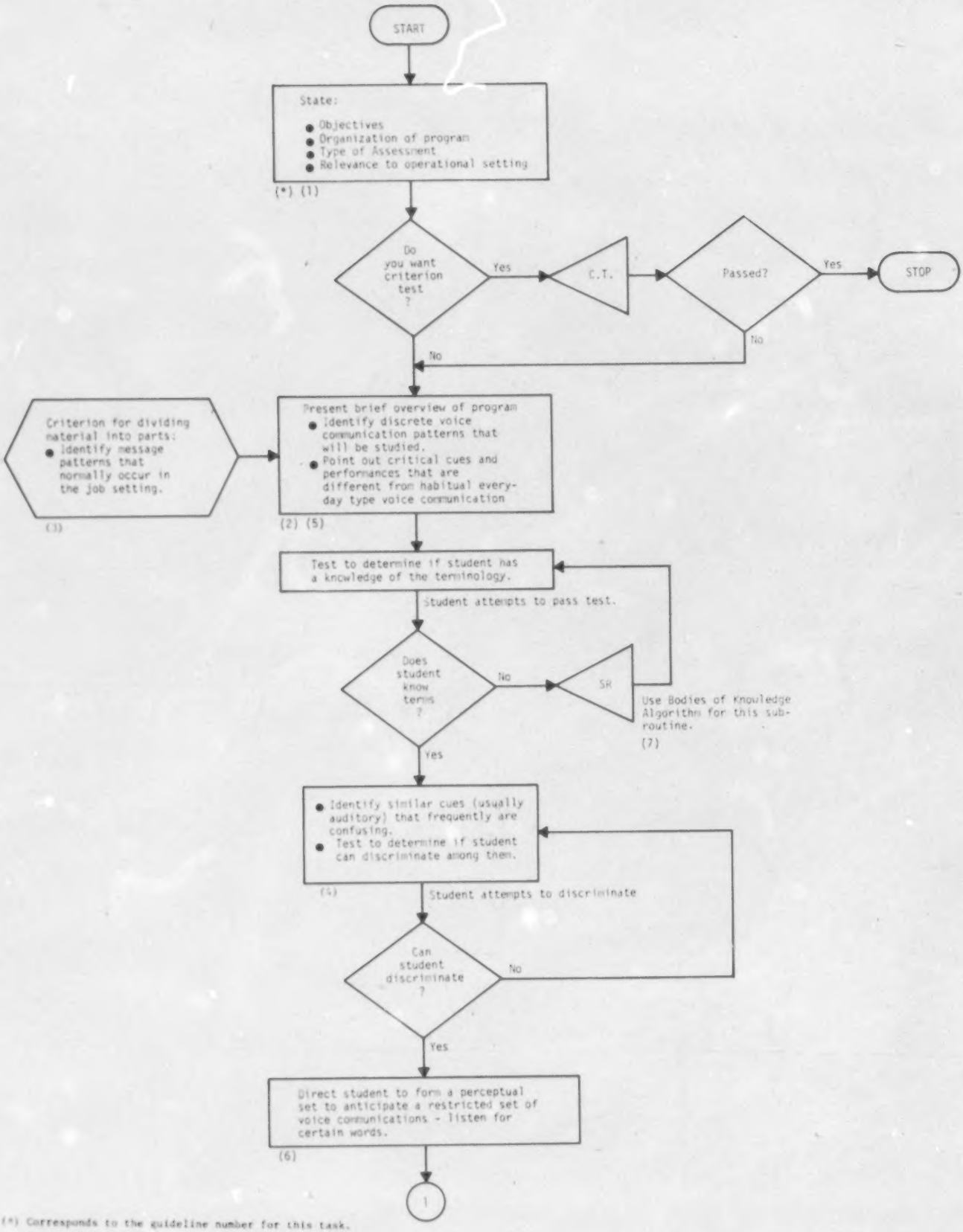
12. Increase distractors and stress conditions equal to that in the operational setting during the later stages of voice communication training.

13. Practice voice communication procedures to the same skill level that will be required in the operational setting.

14. Require student to overlearn correct voice communication procedures so that he can perform them correctly in a distracting, stressful environmental setting.

15. Reinforce the student for meeting the overlearning and operational performance criteria.

16. Insure periodic refresher training where it is indicated by the performance of the person on the job.


START
State:
● Objectives
● Organization of program
● Type of Assessment
● Relevance to operational setting
(*) (1)
Do you want criterion test ?
Yes
C.T.
Passed?
Yes
STOP
No
No
Criterion for dividing material into parts:
● Identify message patterns that normally occur in the job setting.
(3)
Present brief overview of program
● Identify discrete voice communication patterns that will be studied.
● Point out critical cues and performances that are different from habitual every-day type voice communication
(2) (5)
Test to determine if student has a knowledge of the terminology.
Student attempts to pass test.
Does student know terms ?
No
SR
Use Bodies of Knowledge Algorithm for this sub-routine.
(7)
Yes
● Identify similar cues (usually auditory) that frequently are confusing.
● Test to determine if student can discriminate among them.
(4)
Student attempts to discriminate
Can student discriminate ?
No
Yes
Direct student to form a perceptual set to anticipate a restricted set of voice communications - listen for certain words.
(6)
1

(*) Corresponds to the guideline number for this task.

Figure 8. Learning Algorithm for Voice Communicating

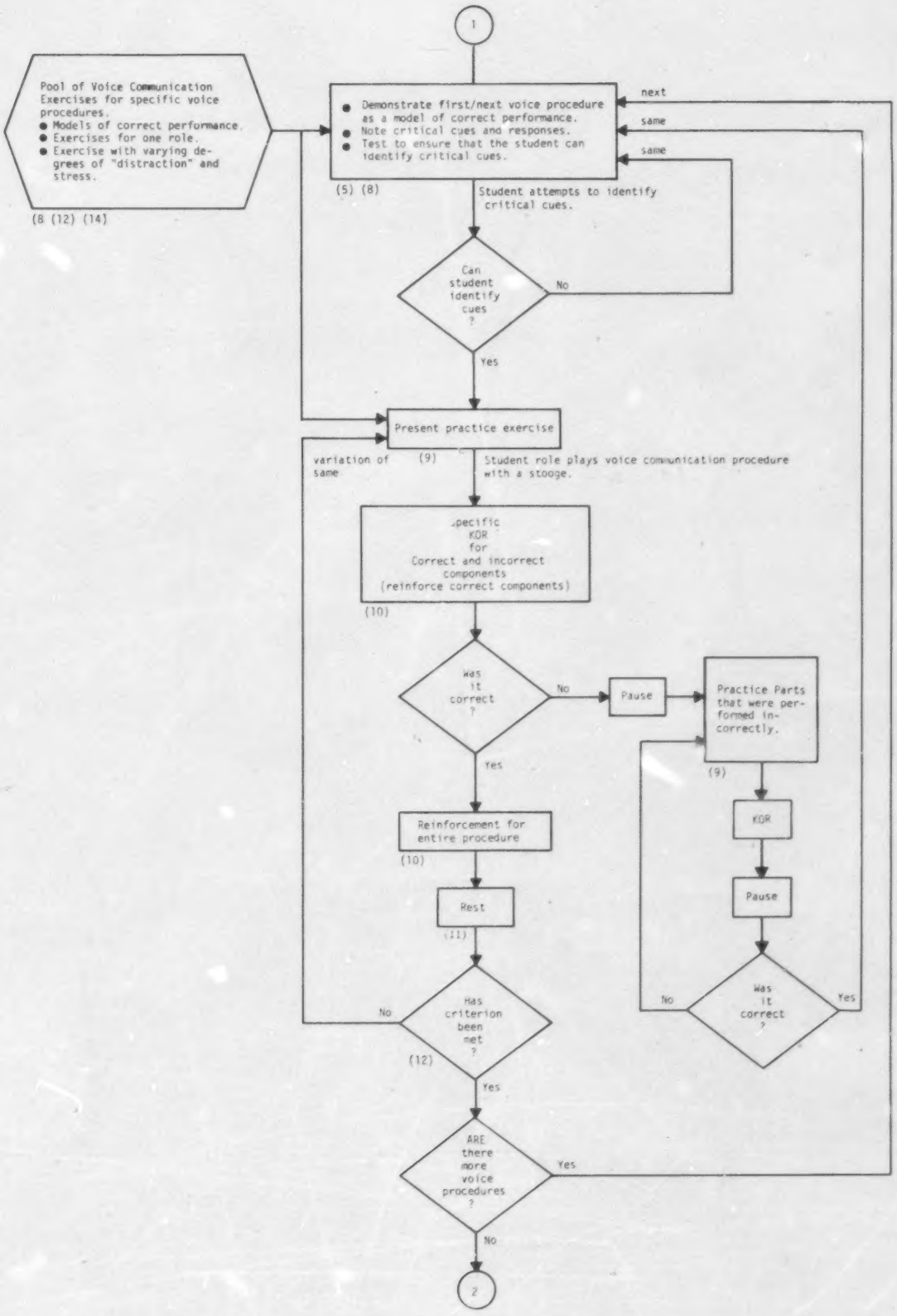


Figure 8. Learning Algorithm for Voice Communicating (continued)

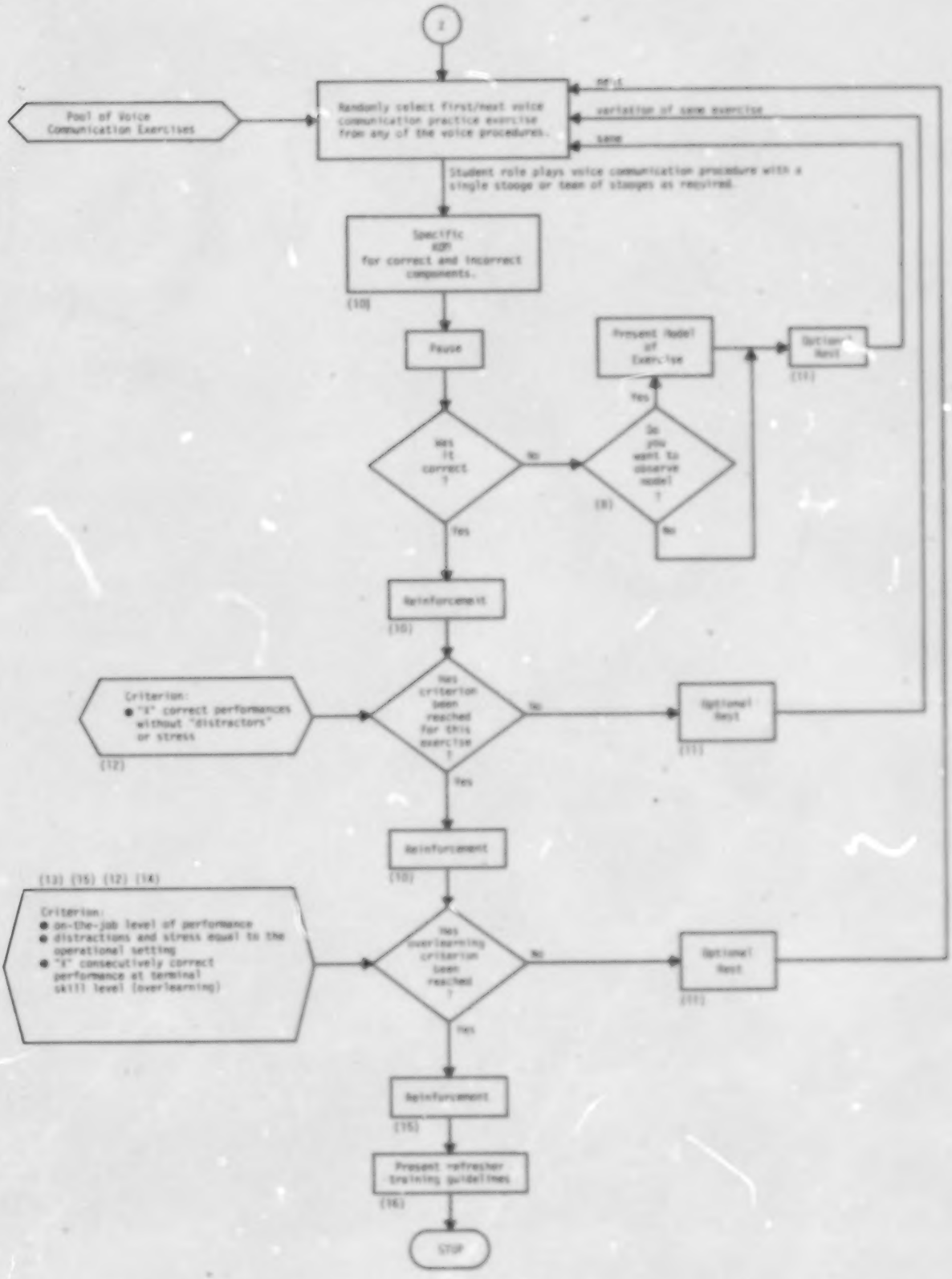


Figure 8. Learning Algorithm for Voice Communicating (continued)

I. RECALLING PROCEDURES AND POSITIONING MOVEMENT

This task category combines two quite different kinds of tasks. Recalling procedures is basically a mental skill, whereas positioning movement is a physical skill. They are combined in these guidelines since they often occur together in the operational setting. They concern carrying out routinized activity, executed as standard operating procedures in some predetermined sequence. Relatively little judgment and analysis are required and a minimum of alternative behavior is involved. Controls are manipulated in an identifiable procedural sequence. Motor movements for control positioning are, at the outset, within the response repertoire of the student; therefore, the emphasis is placed on recalling the sequential procedures and on the accuracy of the positioning movements. An example is the checkout of a piece of communication equipment using a checklist to determine if the equipment is operating within acceptable tolerances. These types of tasks are common and have often been studied with the goal of improving training efficiency.

Guidelines for this behavior are listed below. The algorithm representing these guidelines is presented in figure 9.

1. State clearly the behavioral objectives to be achieved. Describe how the learning materials are organized to achieve this desired behavior. Relate the objectives to the student's future real-world assignments.

2. Break the positioning movement task into appropriate parts and provide subdivisions of organization for each procedure.

3. Divide the procedural steps into small parts if any of the following conditions exist:

   a. Students are of low ability.

   b. The procedures are complex.

   c. The entire procedure is lengthy.

4. Present a demonstration of each task performance (a positioning response to a checklist cue) on an observable model.

5. Show checklist cues and require the student to explain differences in similar cues that serve as association devices for different procedures that have been confused in the past.

6. Use mnemonics which will cause an affective reaction in the student whenever possible to aid in the recall of the procedures to be learned for this task.

7. Use mnemonics (associating procedural steps with imagery, rhymes, or rhythms) to aid in recalling difficult to remember steps. Provide directions for the student to develop his own mnemonics where he is able and willing to do it.

8. Direct the student to practice the following sequence of events to help him remember a chain of procedures.

a. When presented with each checklist item, explain (or perform) its corresponding procedural step.

b. Then when presented with a group of checklist items (as many as the student can handle at once) explain or perform their corresponding procedural steps. The first item of each group should overlap the last item of the previously studied group of steps.

c. Then when presented with a single list of all of the checklist items in the entire procedure, explain (or perform) their corresponding procedural steps.

9. Encourage students to mentally rehearse the procedures called for by the steps in the checklist using mnemonics to aid in the recall of these procedures.

10. Ensure extensive practice early in the training by requiring the learner to:

a. Understand the objective(s).

b. Observe the skilled performance of a model.

c. Strengthen the individual (or component) steps of the desired movement by practicing these steps, obtaining knowledge of results (KOR) and by correcting performance errors.

d. Integrate the steps into a smooth sequence of positioning movements by practicing the sequence of steps.

11. Provide the following conditions for corresponding stages of training:

a. Early in training use:

(1) Immediate and frequent KOR,

(2) Immediate and frequent reinforcement,

(3) little or no operational distractors.

(d) learning material broken-down into small, easily learned parts,

(e) items required to be learned which are relatively easy to acquire,

(f) guiding or prompting of responses.

b. Late in training:

(1) use delayed and infrequent KOR,

(2) use delayed and infrequent reinforcement,

(3) increase distractors to operational level,

(4) a given procedure will be required to be recalled (or performed) in response to the same cues as on the job,

(5) the level of complexity of the procedure, cues and distractor cues should be the same as on the job. Add stress conditions equivalent to that in the operational setting,

(6) eliminate guides or prompts (other than those provided in the operational setting).

12. Make the time interval following KOR much longer than the time interval between the response and KOR, to provide time for the student to sort out errors.

13. Identify features of the operational environment which could be used as mediators to trigger the student's recall of cues.

14. Practice should be distributed, i.e., the timing of practice periods should be determined by:

a. need for rest as judged by the student,

b. requirements of the specific learning material as judged by the instructor.

15. Arrange for extensive repetition (overlearning) by the student to take advantage of the internal feedback properties generated by performing these types of tasks (positioning movement) accompanied by external feedback. Simple repetitive movements may become very dull, i.e., the student experiences feelings to excite and interest and identifies an cues that he is performing the task correctly.

[illegible]

Figure 6. [illegible]

START
Do you want criterion test
Yes
No
C.T.
Passed
Yes
STOP
No
Criterion for dividing task into parts. Smaller parts are appropriate for:
Students with lower ability
Higher complexity tasks
Longer tasks
Present overview of the entire maneuver
Identify the parts that will be practiced separately
Identify scanning requirements
Demonstrate maneuver using model of performance including scan.
Next part
Select first/next part of the maneuver
Same part
Present specific objectives for this part of the maneuver. Test for understanding.
Does student understand
No
Yes
Describe the skill to be performed including motor act, scan pattern and focus.
Demonstrate skilled performance.
Direct student to practice the part of the maneuver.
Practice environment should include:
realistic critical stimulus cues, continuously available during performance of task.
opportunity for high fidelity operator response.
dynamic system behavior - the evolving display-control relationship.
Student attempts to match skilled performance of model, including motor acts, scan and focus.
Next
Next
Immediate KCR
Use shaping technique:
criterion for any specific trial is based on the degree of success achieved on previous trials.
Reinforcement should be contingent upon the student making a response that is an increment closer in approximation to the desired response.
Does student met criterion for this trial
No
Yes
Reinforcement
Are there more parts
Yes
No

Figure 10. Learning Algorithm for Guiding and Steering, Continuous Movement

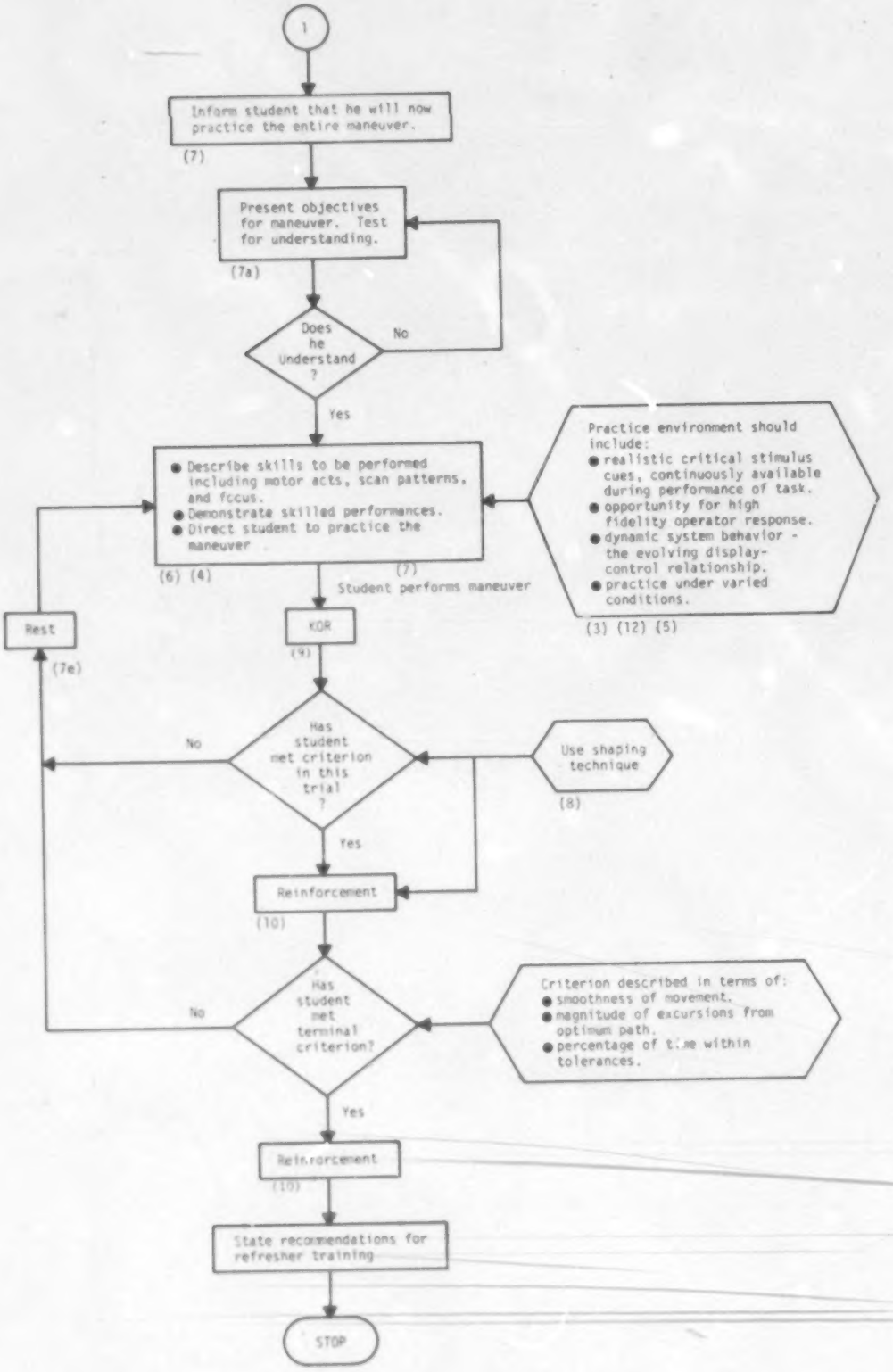


Figure 10. Learning Algorithm for Guiding and Steering, Continuous Movement (continued)

K. PERFORMING GROSS MOTOR SKILLS

This category includes skills characterized by repetitive motor acts involving the use of large muscles. It often includes chaining of movements and a low level of attention by the skillful performer. Fatigue may become a factor in the performance of these skills when performed over an extended period of time. Examples include body movements in many athletic events such as running, swimming, and jumping. These motor acts are controlled by various forms of internal and external stimuli. Proprioceptive stimulation arising in the muscles, tendons, and joints is a primary source of information used in directing this type of skill. Perceptual discrimination including the detection ... relevant external cues is secondary to successful performance. As ... other types of motor skills, conceptual models of correct behavior are usually used as a performance guide and as a baseline for self-evaluation. A high degree of internal and unconscious control governs the discrete acts in this type of skilled behavior.

The guidelines for performing gross motor skills are listed below. The algorithm representing these guidelines is presented in figure 11.

1. Orient student to the learning task by:

    a. Stating the objectives,

    b. Relating the objectives to the operational task he will be performing.

2. Teach the student to discriminate among similar cues within each of these classes:

    a. Objects in the job environment to which the performer must respond with appropriate action (external cues).

    b. Proprioceptive stimuli (internal cues).

3. Facilitate the student's understanding of the task by requiring him to do the following:

    a. Observe a demonstration of the task.

    b. Observe the component parts of the task as it is being presented,

    c. Have the student describe and demonstrate the component parts of the motor task which he observed.

4. Require that the student practice with regard to the following considerations:

a. Practice a simple task in its entirety, or a complex task in parts and then in its entirety.

b. Practice under varied operational conditions. This is done to help adapt the performance of this task to potential environmental changes in the operational setting.

c. Ensure that during practice the student:

(1) Understands the objectives of the skill while learning.

(2) Observes a skilled performance of the desired task as often as necessary.

(3) Obtains feedback concerning his performance of the task (immediate feedback early in training, and a level of feedback appropriate to the operational setting later in training). Encourage the student to respond to internal feedback.

d. Distribute the practice; i.e., provide for rest intervals during training.

5. Ensure that feedback of the following kinds will be provided:

a. Evaluative--student learns what he is doing that is correct or incorrect.

b. Comparative--student learns how his performance compares to the objectives and standard of performance required in the operational setting.

6. Provide a pause of a few seconds after feedback has been given following performance of the motor skill to allow sorting out of errors made during the training performance.

7. Shape the desired performance by reinforcing the student's closest approximation to the desired response.

8. Reduce frequency of reinforcement to the operational level as the student approaches criterion performance.

9. Require the student to overlearn desired performance.

10. Increase distractors towards the end of training to the level

that the person will encounter in the operational setting.

11. Provide for refresher training when the skilled person has not performed the motor skill for an extended period of time.

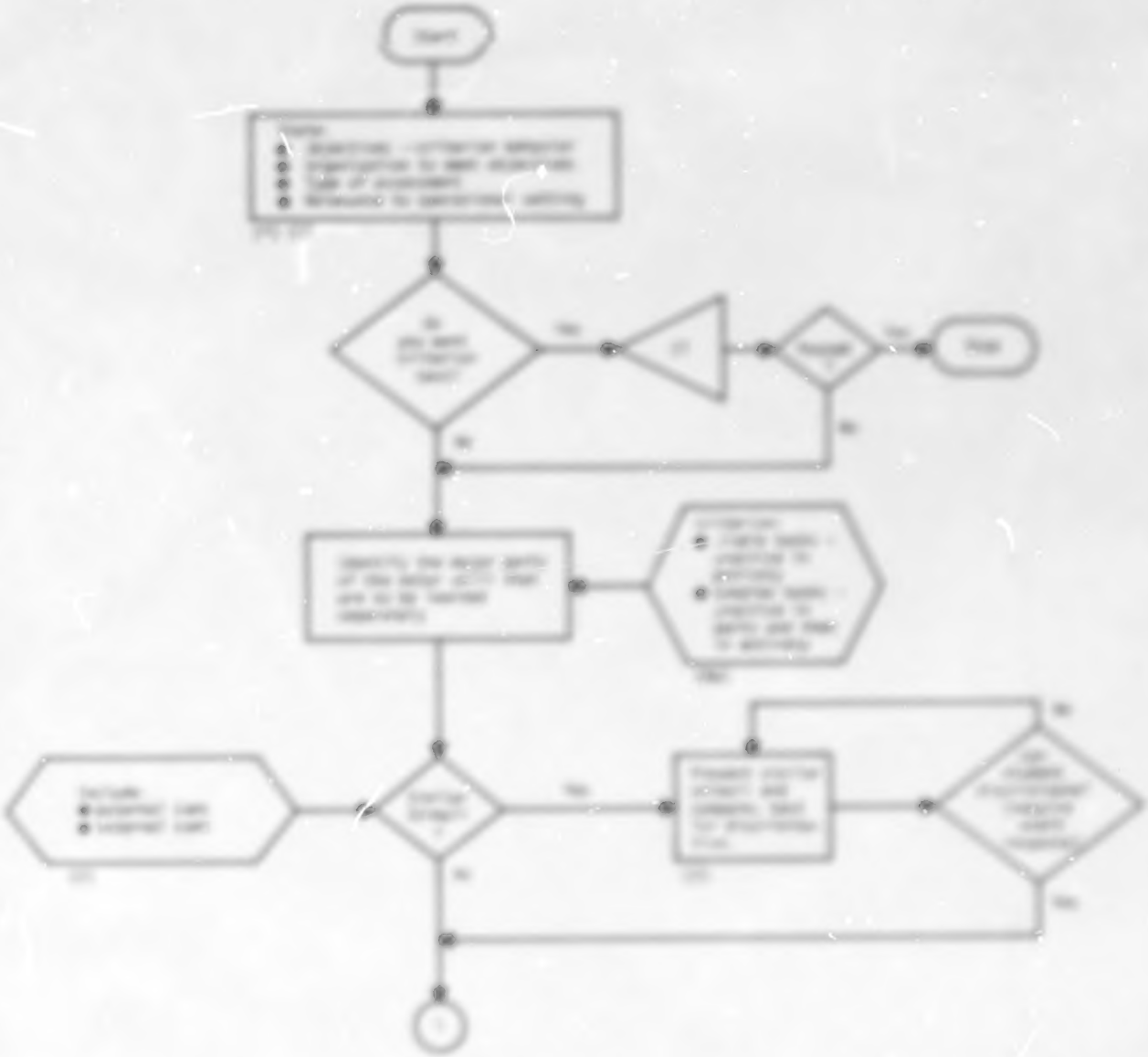


Figure 11. Learning Algorithm for Performing Gross Motor Skills

Figure 11. Learning Algorithm for Performing Gross Motor Activity (continued)

Figure A. Learning Algorithm for Hydrodynamic Drive Motor Shifts (continued)

[illegible]